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Original Article

Microbiology Section

A Cross-sectional Study on Microbiological Patterns Associated with Urinary Tract Infections in Hospitalised Women: Analysis of their Antimicrobial Sensitivity and Clinical Risk Factors

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ABSTRACT

Introduction: Urinary Tract Infections (UTIs) are one of the most common infections, with a predominance in females. To overcome the menace of antibiotic resistance in UTIs, it is important to delineate and follow the local antibiotic resistance patterns of these pathogens. This helps in formulating institutional infection control policies and providing guidance for antibiotic therapy. Knowledge of risk factors for UTIs in hospitalised patients is used to formulate preventive measures for admitted patients.

Aim: To study the microbiological patterns and antimicrobial sensitivity of UTIs in female patients admitted to a tertiary care centre.

Materials and Methods: A cross-sectional study was conducted collaboratively between the Department of Microbiology and the Department of Obstetrics and Gynaecology at RKDF Medical College Hospital and Research Centre, Bhopal, Madhya Pradesh, India. Urine samples were collected from all admitted female patients who were prescribed culture and sensitivity testing by the treating clinicians from November 2020 to October 2022. Demographic and clinical data of patients were collected, and urine samples were sent for culture-sensitivity testing. Identification and antimicrobial susceptibility testing were done using the VITEK2-compact system. Results were analysed using Statistical Packages for the Social Sciences (SPSS) version 23.0.

Results: Out of 508 urine samples sent for culture-sensitivity testing, a culture positivity rate of 16.31% was observed. Diabetes was associated with 25 out of 83 patients. Among all UTI cases, 57.8% (n=48) had a urinary catheter. In catheterised patients, the predominant associated conditions were pregnancy, cardiovascular failure, followed by respiratory issues. Gram-negative isolates constituted 77.1% of the total bacterial isolates, Gram-positive isolates formed 12%, and fungal isolates comprised 10.8% of the total cultures. *E. coli* was the most frequently encountered species, comprising 55.4% of the isolates. The study found carbapenems to be the most effective against *E. coli*. In the present study, Extended Spectrum Beta-Lactamase (ESBL) production was similar in uropathogenic *E. coli* and *K. pneumoniae*, 65.9% and 64.7%, respectively. The present study study showed that aminoglycosides and nitrofurantoin are the optimal drugs for ESBL-producing organisms.

Conclusion: UTIs prevalent in hospitalised women are associated with prolonged catheterisation and co-morbidities such as diabetes and cardiovascular conditions. Gram-negative bacteria are the predominant species, and their susceptibility pattern is increasingly shifting towards higher antibiotics.

Keywords: Anti-infective agents, Culture, Diabetes, Gram-negative bacteria

INTRODUCTION

Urinary Tract Infections (UTIs) are common infections that occur when bacteria, often from the skin or rectum, enter the urethra and infect the urinary tract. Worldwide, approximately 150 million people are diagnosed with UTIs each year, costing the global economy over six billion dollars [1]. UTIs can affect any age group. While males are commonly affected at the two extremes of life, before one year of age and after 50 years, females are susceptible throughout their lives. Each woman has a 60% lifetime risk of developing UTI, while men have a lifetime risk of only 13% [1]. Between 50-80% of women suffer from at least one episode of UTI during their lifetime, most commonly uncomplicated cystitis. Females are more susceptible to UTIs compared to males due to a shorter urethra, absence of prostatic secretions, easy contamination of the tract with faecal flora, and pregnancy [2]. Pregnancy increases the risk of UTI, partly due to the pressure of the gravid uterus on the ureters causing urine stasis, and also due to hormonal and immunological changes during normal pregnancy.

UTIs can affect different parts of the urinary tract, leading to variable symptoms ranging from asymptomatic bacteriuria to pyelonephritis and sepsis. Therefore, UTIs remain the most challenging infectious disease in clinical practice [3]. In developing countries, facilities for urine culture and antimicrobial susceptibility testing are still insufficiently available, leading to improper diagnosis and irrational antibiotic treatment of UTIs, which in turn leads to the emergence of multidrug-resistant strains [4].

Gram-negative bacteria, especially the family *Enterobacteriaceae*, are the most common cause of both community and hospital-acquired UTIs. *Escherichia coli* and *Klebsiella pneumoniae* are commonly implicated among patients with UTI [5,6]. Catheter-associated UTI is one of the most common healthcare-acquired infections [7]. For short- or long-term catheters, the infection rate is about 5% per day. *Escherichia coli* remains the most common infecting organism, but a wide variety of other organisms may be isolated, including yeast species [8]. Women, particularly those aged 16-64 years, are more likely to experience UTIs than men [9]. Specific populations, such as pregnant

women, diabetics, patients with spinal cord injuries, those with urinary catheterisation, and the elderly, are also at an increased risk.

The microbiological aetiology of UTIs has been well-established, with *E. coli* being the most common causative pathogen in 50-80% of cases. Other *Enterobacteriaceae*, such as Klebsiella spp., *Proteus* spp., *Enterobacter* spp., *Enterococcus* spp., *Streptococcus* spp., *Staphylococcus* spp., and *Pseudomonas aeruginosa*, account for most of the remaining positive urine cultures [9]. Empirical antibiotic therapy is commonly prescribed as a result. Due to significant local differences in the frequency of uropathogens and the emergence of new pathogens with changing antimicrobial susceptibility, periodic evaluation of pathogen epidemiology is recommended to revise treatment guidelines.

The antibiotic resistance pattern of uropathogens has been changing over the past years, and it varies from place to place. Current knowledge of the specific burden and susceptibility pattern of *Enterobacteriaceae* isolates in local institutes is essential for appropriate therapy and overcoming the menace of antibiotic resistance, especially in hospitalised patients. Although plenty of literature is available from all over India and globally, there is a deficiency of published work on UTIs in hospitalised females and their antibiotic sensitivity patterns from our region, specifically Bhopal district. Therefore, the present research aimed is to study the occurrence of UTIs in hospitalised women at a local tertiary care centre, deduce the microbiological patterns of isolates specific to the local community, and analyse their susceptibility to various antibiotics. This will help formulate guidance for rational antibiotic usage in local hospitals.

MATERIALS AND METHODS

This cross-sectional study was conducted collaboratively between the Department of Microbiology and the Department of Obstetrics and Gynaecology at RKDF Medical College Hospital and Research Centre in Jatkhedi, Bhopal, Madhya Pradesh, India. The study was carried out from November 2020 to October 2022. A proforma was designed to gather comprehensive demographic and clinical details from each patient, and it was approved by the hospital research committee (RKDFMCHRC/RAC/2020/50).

Inclusion criteria: Hospitalised female patients who were prescribed urine culture and sensitivity testing by their treating clinicians were included in the study.

Exclusion criteria: Outpatient female patients were excluded from the study.

Study Procedure

The proforma was completed for every female patient admitted to the labour room, casualty, various wards, and ICU of the hospital who had been prescribed urine culture and sensitivity testing. Each patient was included in the study only once. If necessary, a clinical examination of each patient was also conducted, and the findings were noted in the proforma. The patients were categorised into two groups: catheterised patients with indwelling catheters and uncatheterised patients.

A mid-stream urine sample was collected using the clean catch technique under aseptic precautions in a sterile wide-mouthed screw-capped container for uncatheterised patients. Catheter samples were also sent to the microbiology laboratory. The samples were immediately processed in the microbiology laboratory, and if there was a delay, they were refrigerated at 2-8°C for no more than three hours. All urine specimens were processed under a biosafety cabinet. Gram staining, wet mount preparation, and primary inoculation of the samples were performed on the day of receipt. The samples were inoculated using the four-flame method (streak culture).

The specimens were inoculated on the following media:

- Cystine-lactose-electrolyte-deficient (CLED) agar
- MacConkey agar
- Nutrient agar
- 5% sheep blood agar

All inoculated plates were incubated aerobically at 37°C for 16-18 hours. The number of colonies on CLED agar was counted. If no growth was observed within 24 hours, the plates were further incubated for an additional 24 hours. After 48 hours, if there was still no growth, the sample was reported as “no organism isolated.” The colony count on CLED agar was reported as significant growth if, it met the interpretative criteria for urine cultures [Annexure 1] [10].

MacConkey agar was used to differentiate and separate lactose and non lactose fermenting organisms. Nutrient agar was used for performing biochemical tests, and sheep blood agar was used to demonstrate the haemolytic properties of organisms. If, fungal growth was suspected based on Gram staining and wet mount, a subculture on Sabouraud Dextrose Agar was performed. If the Gram stain showed Gram-positive cocci, the following biochemical tests were conducted:

- Catalase test.
- Coagulase test to identify *S.aureus.*
- Bile Esculin test to identify *Enterococcus* spp.
- Oxidase test for identification of *Pseudomonas aeroginosa.*

STATISTICAL ANALYSIS

Organism identification and antimicrobial susceptibility testing were performed using the VITEK2 compact automated system. The samples were reported as sensitive, intermediate, or resistant based on the Clinical and Laboratory Standards Institute (CLSI) guideline [11]. The results of culture and sensitivity testing were recorded in the proforma. The proforma was analysed using the SPSS version 23.0.

RESULTS

A total of 508 urine samples were sent for culture and sensitivity testing, and out of these, 83 samples showed significant growth on CLED agar, resulting in a culture positivity rate of 16.31%. The frequency of positive urine cultures was higher in patients above the age of 50 years, with the majority of patients with UTIs being above 70 years old (21/83, 25.3%). This was followed by 13 (15.7%) of patients in the age groups of 51-60 years and 61-70 years. Sexually active young adults in the age groups of 21-30 years and 31-40 years accounted for 10 (12%) and 12 (14.4%) of the positive cultures, respectively [Table/Fig-1]. More than half of the culture positive patients had an indwelling catheter [Table/Fig-2], and most of these patients had the catheter for more than a week [Table/Fig-3]. The positive samples were received from patients admitted with various diagnoses, with

Age (years)	Percentage of positive samples (%)
<1	1 (1.2%)
1-10	1 (1.2%)
11-20	4 (4.81%)
21-30	10 (12.04%)
31-40	12 (14.45%)
41-50	8 (9.63%)
51-60	13 (15.66%)
61-70	13 (15.66%)
>71	21 (25.30%)

[Table/Fig-1]: Age-wise distribution of female patients with UTI (N=83).

Catheter status	n (%)
Patients with catheter	48 (57.8%)
Patients without catheter	35 (42.1%)

[Table/Fig-2]: Catheter status of female UTI patients when sample was collected (N=83).

the most common being pregnancy and cardiac failure [Table/Fig-4]. Out of the 83 culture positive samples, 25 were found to be diabetic, and 23 had elevated liver enzymes. The most common co-morbidity in the culture positive patients was renal failure [Table/Fig-5].

Duration of catheter in-situ (Days)	n (%)
Upto 2	07 (14.5)
3-7	14 (29.1)
8-30	22 (45.8)
>30	05 (10.4)

[Table/Fig-3]: Duration of catheter in-situ in catheterised patients (n=48).

Clinical diagnosis	Urinary catheter	
	Present (n=48)	Absent (n=35)
Pregnancy	10	03
Gynaecological disease	03	01
Recurrent UTI	02	04
Renal infections-pyelonephritis/urosepsis	O2	03
Other renal conditions	02	02
Cardiovascular failure	08	04
Septic shock	03	02
Respiratory failure and pulmonary conditions	05	01
Stroke/encephalopathy	03	01
Road traffic accident	01	01
Long bone fractures	03	03
Burns	01	03
Seizures/poisoning/diabetic ketoacidosis	02	02
Malignancy	03	05

[Table/Fig-4]: Distribution of associated clinical conditions in UTI patients (N=83).

Co-morbidity	Positive samples (%)
Renal failure	37 (44.6%)
Elevated liver enzymes	23 (27.7%)
Previous UTI	18 (21.7%)
Second organism	32 (38.5%)
Diabetes	25 (30.1%)

[Table/Fig-5]: Distribution of other co-morbidities in positive samples (N=83).

The most commonly isolated organism was *E. coli*, followed by *Pseudomonas* and *Enterococci*. Fungal isolates accounted for 10% of the growths on culture [Table/Fig-6]. A significant proportion of *E. coli* growth samples were received from the ICU [Table/Fig-7], while an equal proportion of other uropathogens were isolated from the wards. In both diabetic and non diabetic patients, *E. coli* was the most common organism, but the second most common organism differed between the two groups. *Pseudomonas* was the second most common organism in non diabetics, while in diabetics, it was *E. faecium* [Table/Fig-8].

Organism	N (%)
E. coli	46 (55.4)
K. pneumoniae	04 (04.8)
E. cloacae	02 (02.4)
P. aeruginosa	07 (08.4)
P. putida	01 (01.2)
A. baumanii	02 (02.4)
P. rettgeri	02 (02.4)
S. maltophilia	01 (01.2)
E. faecium	07 (08.4)
E. faecalis	01 (01.2)
S. aureus	01 (01.2)
C. tropicalis	05 (06.0)
C. albicans	02 (02.4)
C. lucitaniae	01 (01.2)
Myroides spp.	01 (01.2)

[Table/Fig-6]: Distribution of bacterial and fungal isolates in culture positive urine samples of admitted female patients (N=83).

Organisms	Location in hospital							Total
	ICU	Gynaec ward	Ortho ward	Paedia ward	Surgery ward	Casualty	Medicine ward	
E. coli	16	01	01	01	08	01	18	46
K. pneumoniae	02	0	0	0	01	0	01	04
E. cloacae	0	0	01	0	0	0	01	02
P. aeruginosa	05	0	0	0	02	0	0	07
P. putida	01	0	0	0	0	0	0	01
A. baumanii	02	0	0	0	0	0	0	02
P. rettgeri	02	0	0	0	0	0	0	02
S. maltophilia	0	0	0	0	0	0	01	01
E. faecium	05	0	0	0	0	0	02	07
E. faecalis	0	01	0	0	0	0	0	01
S. aureus	0	0	0	0	0	0	01	01
C. tropicalis	05	0	0	0	0	0	0	05
C. albicans	02	0	0	0	0	0	0	02
C. lucitaniae	01	0	0	0	0	0	0	01
Myroides spp.	01	0	0	0	0	0	0	01
Total	42	02	02	01	11	01	24	83

[Table/Fig-7]: Distribution of bacterial and fungal isolates according to patient's location in the hospital (N=83).
Gynae: Gynecologist; Ortho: Orthopaedic: Paedia: Paediatrics

Organism	UTI with diabetes mellitus (%) (n=25)	UTI in non diabetics (%) (n=58)
A. baumanii	0	4.6
C. albicans	3.3	4.3
C. tropicalis	3.3	7.6
C. lucitaniae	1.6	0
E. coli	52.5	38.1
E. faecium	11.5	4.6
K. pneumoniae	6.6	9.9
P. aeruginosa	6.6	15.3
E. cloacae	0	2.3
E. faecalis	0	3
Myroides spp.	0	0.8
P. putida	1.6	0.8
P. rettgeri	4.9	2.3
S. aureus	3.3	1.5
S. maltophilia	4.8	4.9

[Table/Fig-8]: Percentage distribution of various uropathogen isolates in relation to the diabetic status of the patients.

The resistance patterns of *E. coli* showed high resistance to most antibiotics, except nitrofurantoin, amikacin, and the carbapenems. Klebsiella was only sensitive to colistin [Table/Fig-9]. Gram-positive organisms showed good sensitivity to linezolid, teicoplanin, and vancomycin [Table/Fig-10]. The fungal isolates were sensitive to most antifungal agents [Table/Fig-11].

Of the *E. coli* isolates, 65% were found to be ESBL producers [Table/Fig-12]. In catheterised patients, 78.9% of *E. coli* isolates were ESBL producers, while 60% of *K. pneumoniae* isolates were ESBL producers. In uncatheterised patients, 54.5% of *E. coli* isolates were ESBL producers. Among the *E. coli* isolates from ward samples, 56.2% were ESBL producers, while in the ICU, 79.4% of *E. coli* isolates were ESBL producers, indicating resistance to routine antibiotics.

Antimicrobial agent	*E. coli* n=46 (%)	*K. pneumoniae* n=04 (%)	*P. aeruginosa* n=07 (%)	*A. baumanii* n=2 (%)	*P. rettgeri* n=2 (%)
Ampicillin-sulbactum	21 (45.6%)	2/4 (50)	NA	2/2 (100)	2/2 (100)
Aztreonam	21 (45.6%)	2/4 (50)	4/7(57.1)	NA	2/2 (100)
Amikacin	7 (15.2%)	2/4 (50)	4/7(57.1)	1/2 (50)	2/2 (100)
Amoxycillin-clavulanic acid	18 (39.1%)	3/4 (75)	NA	NA	2/2 (100)
Ampicillin	37 (80.4%)	NA	NA	NA	2/2 (100)
Cefepime	24 (52.1%)	2/4 (50)	4/7 (57.1)	2/2 (100)	2/2 (100)
Cefotaxime	33 (71.7%)	2/4 (50)	NA	2/2 (100)	2/2 (100)
Ceftriaxone	33 (71.7%)	3/4 (75)	NA	1/2 (50)	2/2 (100)
Cefuroxime	34 (73.9%)	3/4 (75)	NA	NA	2/2 (100)
Ceftazidime	31 (67.3%)	2/4 (50)	5/7 (71.4)	2/2(100)	2/2 (100)
Trimethoprim-sulfamethoxazole	32 (69.5%)	2/4 (50)	NA	2/2 (100)	2/2 (100)
Ciprofloxacin	33 (71.7%)	2/4 (50)	4/7 (57.1)	2/2 (100)	2/2 (100)
Imipenem	7 (15.2%)	2/4 (50)	4/7 (57.1)	2/2 (100)	2/2 (100)
Meropenem	7 (15.2%)	2/4(50)	4/7 (57.1)	2/2 (100)	2/2 (100)
Levofloxacin	34 (73.9%)	3/4 (75)	4/7 (57.1)	2/2 (100)	2/2 (100)
Norfloxacin	34 (73.9%)	3/4 (75)	5/7 (71.4)	2/2 (100)	2/2 (100)
Ofloxacin	35 (76.1%)	3/4 (75)	5/7 (71.4)	2/2 (100)	2/2 (100)
Gentamycin	26 (56.5%)	3/4 (75)	4/7 (57.1)	1/2 (50)	2/2 (100)
Cefoperazone-sulbactum	9 (19.6%)	NA	4/7 (57.1)	1/2 (50)	2/2 (100)
Piperacillin	34 (73.9%)	3/4 (75)	4/7 (57.1)	2/2 (100)	2/2 (100)
Ticarcillin-clavulanic acid	28 (60.8%)	2/4 (50)	4/7 (57.1)	2/2 (100)	2/2 (100)
Tetracycline	24 (52.1%)	3/4 (75)	NA	2/2 (100)	2/2 (100)
Tobramycin	20 (43.4%)	2/4 (50)	5/7 (71.4)	1/2 (50)	2/2 (100)
Nitrofurantoin	8 (17.4%)	2/4 (50)	4/7 (57.1)	1/2 (50)	2/2 (100)
Colistin	0	1/4 (25)	0	0/2 (0)	2/2 (100)

[Table/Fig-9]: Antimicrobial drug resistance in percentage of most common Gram negative uropathogens.

Antimicrobial agent	*E. faecium* n=7	*E. faecalis* n=1 (%)	*S. aureus* n=1 (%)
Penicillin	6/7 (85.7)	1/1 (100)	1/1 (100)
Ampicillin	7/7 (100)	1/1 (100)	NA
Erythromycin	NA	NA	0/1(0)
Clindamycin	NA	NA	0/1(0)
Linezolid	0/7 (0)	0/1 (0)	0/1(0)
Vancomycin	1/7 (12.9)	0/1 (0)	0/1 (0)
Teicoplanin	1/7 (12.9)	0/1 (0)	0/1 (0)
Oxacillin	NA	NA	0/1 (0)
Cefoxitin	NA	NA	0/1 (0)
Streptomycin	5/7 (71.4)	0/1 (0)	NA
Gentamycin	5/7 (71.4)	0/1 (0)	NA
Ciprofloxacin	7/7 (100)	1/1 (100)	1/1 (100)
Levofloxacin	6/7 (85.7)	1/1 (100)	1/1 (100)
Norfloxacin	6/7 (85.7)	NA	1/1 (100)
Tetracycline	5/7 (71.4)	1/1 (100)	0/1 (0)
Nitrofurantoin	4/7 (57.1)	0/1 (0)	0/1 (0)
Cotrimoxazole	NA	NA	1/1 (100)
Gentamycin	NA	NA	0/1 (0)

[Table/Fig-10]: Antimicrobial drug resistance in percentage of Gram-positive uropathogens.

DISCUSSION

The present cross-sectional study aimed to describe the distribution of uropathogens based on various clinical risk factors and their patterns of antimicrobial resistance. The culture positivity rate was found to be 16.3% (n=83). Age is a crucial factor that affects innate immunity and susceptibility to infections, including UTIs. In present study, a higher frequency of positive urine cultures was observed in individuals above the age of 50 years. The majority of UTI cases were found in individuals above 70 years old 21 (25.3%), followed by 13 (15.7%) in the age groups of 51-60 years and 61-70 years. Sexually active young adults between the ages of 21-30 years and 31-40 years accounted for 10 (12%) and 12 (14.4%) of the positive cultures, respectively. Similar findings were reported by Tiruneh M et al., where individuals above 50 years old accounted for 22.2% of total UTIs [12].

Antimicrobial agent	*C. albicans* n=2	*C. tropicalis* n=5 (%)	*C. lucitanae* n=1
Flucytosine	0	0	0
Fluconazole	0	1 (20)	0
Voriconazole	0	1 (20)	0
Amphotericin B	0	0	0
Micafungin	0	0	0
Caspofungin	0	0	0

[Table/Fig-11]: Antimicrobial drug resistance in percentage of fungal uropathogens.

Organism	ESBL producer	ESBL non-producer
E. coli	65.9%	34.1%
K. pneumoniae	64.7%	35.3%

[Table/Fig-12]: ESBL production status of uropathogens.

Catheterisation and its duration are significant factors that influence susceptibility to urinary infections. In present study, 57.8% of UTI cases had a urinary catheter. The majority of cases (45.8%) had a catheter for 8-30 days. This aligns with the study done by Letica-Kriegel AS et al., where the catheter-associated UTI-free survival rate was 97.3% at 10 days, 88.2% at 30 days, and 71.8% [13].

When analysing the distribution of urine samples with positive culture reports from various locations in the hospital, it was found that positive samples were equally received from ICUs and wards, constituting 42 and 41 samples out of the 83 positive reports, respectively. The study also found that the medical ward contributed to the highest number of positive samples (24/83) among all wards. Magill S et al., have reported a significantly higher positivity rate from the ICU (27%) compared to wards (9.3%) [14]. Most studies have found a higher infection rate in ICUs, but present study found an equal rate, possibly due to better infection control in ICUs and the admission of more complicated medical and surgical cases in wards, as hospital is a tertiary care centre [15].

Complicated UTIs are defined as UTIs associated with factors that compromise the urinary tract or host defense, including urinary obstruction, urinary retention caused by neurological disease, immunosuppression, renal failure, renal transplantation, pregnancy, and the presence of foreign bodies such as calculi, indwelling catheters, or other drainage devices [15]. The present study identified an association with diabetes in 25/83 patients. Analysis of the clinical background of 48 catheterised patients revealed that the predominant associated conditions were pregnancy (10/48) and cardiovascular failure (8/48), followed by respiratory issues (5/48). Other conditions such as road traffic accidents, seizures, malignancy, and septic shock were distributed more evenly. Hazelett S et al., have reported similar findings regarding various co-morbid conditions [16]. These associated factors can be used to identify patients at high risk for UTI, and more aggressive measures can be employed to prevent infection in such patients, such as minimising the duration of catheterisation.

In present study, Gram-negative isolates constituted 77.1% of the total bacterial isolates, followed by Gram-positive isolates (12%) and fungal isolates (10.8%) of the total cultures. *E. coli* was the most frequently encountered species, comprising 55.4% of the isolates. This aligns well with studies from Europe, where *E. coli* isolates

ranged from 47.6% to 85.9%, and studies from the American continent, which reported *E. coli* in 57.5% to 71.6% of isolates [17-21]. Other bacteria isolated from urine samples included *P.aeruginosa* (7/83, 8%), *E. faecium* (7/83, 8%), *K. pneumoniae* (4/83, 4.8%), *Proteus* spp. (3/83, 3.6%), *A.baumanii* (1/83), and *S.aureus* (1/83). This correlates with other reports where *P.aeruginosa* was the second most common bacterial isolate in UTI, but not with studies where Klebsiella was the second most frequent species [22-24]. Candida species constituted 8 (9.6%) of the isolates. Previous studies indicate that at least 10-15% of hospital-acquired UTIs are caused by candida species. Candiduria is especially common in ICUs and may represent the most frequent UTIs encountered in surgical ICUs [25]. When tracing the antibiotic resistance patterns of these isolated uropathogens, present study found that carbapenems were the most effective against *E. coli*. Another study conducted by Goel N et al., in India showed that meropenem was highly effective against Gram-negative bacilli, while they showed high resistance to cephalosporins [26]. A study done in King Fahad Hospital Saudi Arabia showed that ESBL-producing *E. coli* showed 4.2% resistance to meropenem, followed by amikacin (6.3%) and imipenem (8.3%) [27].

Fluoroquinolones in present study showed high resistance rates among uropathogens, particularly *E. coli*. This high rate of resistance was also shown in a study done by Kothari A and Sagar V in India [28]. However, these findings did not correlate with the study by Theodore M, which showed high susceptibility [29]. In present study, resistance rates of colistin and tigecycline were low in all tested Gram-negative uropathogens, ranging from 0-25%, except for *Proteus* spp. which showed 100% resistance. *A.baumanii* showed resistance rates ranging from 50-100% for all antibiotics except colistin, to which it showed 0% resistance. *P.rettgeri* was found to be a highly resistant organism in our study, showing high resistance to all antimicrobials. These findings corroborate with the study by Theodore [29].

E. faecium was 100% susceptible to linezolid, and resistance to vancomycin and teicoplanin was lower. *E. faecalis* and *S. aureus* were 100% susceptible to vancomycin, teicoplanin, linezolid, and nitrofurantoin. The resistance patterns of these uropathogens correlate well with the study done by Levitt PN [30].

C. tropicalis was equally susceptible to amphotericin-B, caspofungin, and micafungin (100%). Its resistance rates for other antifungals were 20%. *C. albicans* and *C. lucitaniae* were 100% susceptible to all antifungals. This is in line with a study on in-patients from Goa, where similar isolation rates and susceptibility patterns of fungal isolates were seen, pointing to the presence of predisposing factors for fungal infections in Inpatient Department (IPD) patients, such as steroid prescriptions, prolonged antibiotic use, and chronic illnesses leading to reduced immunity [31].

E. coli and *K. pneumoniae* are the most commonly isolated uropathogens. They have developed resistance to common antimicrobial agents over time by producing ESBL enzymes. ESBL-producing isolates are therefore clinically and microbiologically significant as they are resistant to routine antibiotics. In the present study, ESBL production was similar in uropathogenic *E. coli* and *K. pneumoniae*, 65.9% and 64.7%, respectively. The highest isolation rate of ESBL-producing *K. pneumoniae* has been reported from Latin America (54.4%), while it was 22.6% from Europe. The frequency of ESBL-producing *E. coli* in these areas was 8.5% and 5.3%, respectively [32].

In present study, among all *E. coli* isolates from catheterised patients, 78.9% were ESBL producers. This points to a correlation between catheterisation and ESBL production. ESBL-producing *E. coli* was found in both wards and ICUs, but in ICUs, 79.4% of the *E. coli* isolates were ESBL producers. In the case of *K. pneumoniae*, there wasn't much difference in the percentage of ESBL-producing isolates between wards and ICUs. These ESBL-producing strains were 100% resistant to third-generation cephalosporins. A study reported from Madagascar showed that ESBL-producing isolates had an 80% resistance rate to ampicillin, while in present study, the resistance to ampicillin was 100% [33].

In present study, ESBL-producing *E. coli* and *K. pneumoniae* showed 79.2% and 100% resistance to cotrimoxazole. A study from Iran showed resistance rates of 80% and 45% to cotrimoxazole among ESBL-producing *E. coli* and *K. pneumoniae* [34]. The fluoroquinolones showed high resistance rates ranging from 88% to 92.5% among ESBL-producing *E. coli* and 90.9% in ESBL-producing *K. pneumoniae* in this study. This reflects incorrect antibiotic usage for these infections and is comparable to the findings of another study [35]. ESBL-producing *E. coli* showed a much lower resistance rate to amikacin (24%) compared to *K. pneumoniae* (81.8%) in present study, while another study showed that *K. pneumoniae* had a resistance rate of 38% to amikacin [36]. The resistance rates of ESBL-producing *E. coli* and *K. pneumoniae* to nitrofurantoin were 24% and 80%, respectively, in present study. The present study showed that aminoglycosides and nitrofurantoin are the optimal drugs for ESBL-producing organisms in setup.

The present study has identified the uropathogens in hospitalised patients and highlighted their ever-shrinking sensitivity patterns. Each uropathohgen in this study has shown unique sensitivity patterns, and culture and sensitivity testing is the diagnostic test of choice to prescribe antibiotics for urinary symptoms in admitted patients, as the organisms in hospital settings may be uncommon compared to those found in the community. Prolonged catheterisation increases the risk of these infections and shows the growth of resistant ESBL-producing uropathogens. ESBL production is the biggest challenge in the treatment of UTIs.

Limitation(s)

The scope of the study did not include infection by a second organism or patients being readmitted for UTIs. As the occurrence of UTI can be influenced by several comorbidities, a larger sample size is required to determine the exact correlation of each factor with the occurrence of UTI in hospitalised patients. This study was not able to calculate that, which is a drawback of the study.

CONCLUSION(S)

The most common pathogen causing UTI in admitted female patients was *E. coli*. As drug resistance among uropathogens is changing both geographically and temporally, regular surveillance and sensitivity testing is necessary to provide clinicians with updated information on the most effective treatment of UTIs. Antibiotic prescription for the treatment of UTI should be based on the knowledge of the local prevalence of uropathogens and their antibiogram, rather than on universal guidelines. Complicated UTIs in hospitalised patients can be prevented by delineating the specific areas of the hospital where UTIs are more prevalent and identifying the clinical conditions commonly associated with UTIs. Patients who are likely to have complicated UTIs should not be subjected to empirical therapy due to the high risk of antimicrobial resistance.

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[ANNEXURE 1] [10]

Result of culture	Specimen type	Associated clinical condition	Processing/work-up
>/=10^4 CFU/mL of a single potential pathogen or for each of two potential pathogens	Clean catch, midstream sample, Catheter sample	Asymptomatic bacteriuria, cystitis, pyelonephritis	Complete work-up
>/=10^3 CFU/mL of a single potential pathogen	Clean catch midstream sample, Catheter sample	Symptomatic males or acute urethral syndrome	Complete work-up
>/=3 organism types with no predominant organism	Clean catch midstream sample, Catheter sample		Possible contamination. Repeat sample.
2 or 3 organism types with predominant growth of one organism type and <10^4 CFU/mL of the organism types	Clean catch midstream sample		Complete work-up for the predominant organism
>10^2 CFU/mL of any number of organism types	Suprapubic aspirates, surgically collected urine e.g., ileal conduits, cystoscopy		Complete work-up